Heimdall: a plataform to empower common IoT services into a smart ecosystem

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Abstract. The emergence of the Internet of Things (IoT) paradigm fuel the discussion of how urban environments will benefit from applications of the IoT domain, to name a few, smart grids, smart vertical farm and healthcare applications. Domains likewise vertical smart farm are envisioned to share the same space as people and machines even if humidity and temperature conditions required to grow plants are not ideal to systems room, nor to workplaces, which make the design of these environments even more challenging. Under this point of view more complex concepts such as smart ecosystems (smart cities, smart agriculture and Industry 4.0) flourished. There is still a lack of IoT solutions to integrate services rising new and customized applications. Heimdall is a microservices platform that aim to provide comprehensive services allowing users to storage and visualize data streams gathered by IoT systems. Built to explore continuous integration tools, Heimdall is envision to run a flexible and powerful infrastructure able to provide elastic resource. In other words, Heimdall is a solution to power smart ecosystems.

Keywords: smart ecosystem, smart environment, IoT microservices.

1 Introduction

The Internet of Things (IoT) is related to the interconnection of sensing and actuating devices (named smart objects) with the Internet [1] [2]. Some concepts benefit highly from the IoT perspective such as smart city in urban areas [5], smart farming, smart agriculture and precision agriculture in countryside [7], and industry 4.0 [4].

The Smart City concept support the ideal of a city where investments in human/social capital, technology and infrastructure fuel sustainable development, enhanced quality of life and culture exchange built by independent and aware citizens [6]. IoT systems for urban areas enhance the efficiency of the management of key resources such as water and energy as well as urban mobility, accessibility services, among others. From countryside areas, the management of farming cycle supports proprietary systems that turn possible big stakeholders to become part of a highly integrated food supply chain or small urban collaborative systems of indoor urban production sites supported by a smart delivery system [7]. For the industry, IoT has a key role for a new revolution which is leading us to the industry 4.0 [4]. Industry 4.0 concept foresee the possibility of elastic supply, from which any product demand becomes feasible to attend. The objective is manage real-time interactions between people, products and devices during the production process [4]. In other words, factories may accept consumer orders, directly produces and deliver it without the aid of separate sales and circulation channels.

A common ground among these concepts is the aggregate value provided by the collaboration of connected small world composed of smart objects working collaboratively to enhance the quality of human lives [3]. With emergence of new and easier to use products the demand for more complex smart objects interactions grow. Over this viewpoint, despite of the existence of a reference architecture and solution addressing the interoperability issue, IoT interactions afford little dynamism when compared to social networks. The Social IoT (SIoT) proposal is the adoption of human relationship patterns to enable smart objects to build relationships molding smart environment into social networks [14]. The desired result is able to unfold and exploit synergies that favors the creation of ecosystems composed of smart objects enabling them to interact dynamically in a way that both the smart objects and its users can benefit mutually.

Indeed, city, countryside and industry demand different solutions of IoT. These solutions should work together in the interest of collaborating as part of an ecosystems. Therefore, it will possible to reach more complex and suitable IoT services. However, there is still a lack of scalable easy to use platform as an environment to support the design of IoT solutions and also aim the creation of smart objects ecosystems able to make feasible the aforementioned abstraction.

This paper provides a holistic view over the enable technologies of the above mentioned scenario and the thought behind Heimdall, a Microservices platform envisioned to support the creation of IoT ecosystems in a scalable, reusable and flexible way. The Heimdall proposition is then a reference to platform to support IoT ecosystems. This paper is organized as follow. Section 2 provides a overview on enable technologies. Section 3 discuss existing cloud related products. In Section 4 we present the thought behind Heimdall, section 5 provides future works and a final remarks.

2 Enabling Technologies

Over the last decade a series of cutting edge technologies have been aggregated to the IoT spectrum. This section present a rapid overview on enabling technologies of the IoT paradigm. These technologies are commonly clustered into two main groups (i) smart objects (e.g. sensors, actuators and embedded communication hardware) and (ii) analytics solutions (on demand storage and data analytics technologies over a cloud computing infrastructure).

2.1 Smart Objects Solutions

Under the things oriented point of view RFID, NFC tags, wireless sensor networks (WSN) and mobile technologies are among the most promising technologies to enable the data acquisition and networking layer of the IoT [1] [2]. RFID and NFC are technology that allows the identification of anything that they attached. NFC technology connects mobile devices through a wireless link that can send small amounts of data. The applications of the NFC technologies include their use as a secret digital token to unlock booked rooms, start a car, enable payments, and so on [10].

WSNs are composed of large number of low cost, low power miniature devices communicating in a wireless multihop fashion. WSNs are able to collect, process environmental data and act based on sensed behavior. WSNs (wireless sensor network) are usually featured as fit-for-purpose network designed to attend the requirements of previously known application. Due to its versatile feature, WSNs are envisioned to play an essential role making critical infrastructure components responsible to acquire and semantically improve data, as well as, it provide interoperability with other technologies.

Through the usage of participatory and opportunistic sensing strategies combined with infrastructure-based transmission or opportunistic transmission technologies, the Crowd Sensing paradigm appears as a powerful approach to embody human participation into the IoT paradigm[11][12]. Participatory sensing presume the proactive participation of humans that consciously decide to share its information meeting the applications requests. The opportunistic sensing run in the background exploiting the sensor units of the mobile devices to collect data without active involvement of users. Regarding transmission technologies, infrastructure-based transmission the reports are sent with the aid of an enterprise network infrastructure (3G and 4G technologies). In Opportunistic transmission scenario data is conveyed through intermittent connections with short-range radio communications (wifi and bluetooth technologies). Therefore, crowdsensing consists in the acquisition of information regarding human activity from agents that are widely spread through the monitored environment. Thus enabling access to data that is essential to the recognition of patterns in the human use of smart environments [11] [12].

2.2 Analytics Solutions

Decision making is a process supported by a multifaceted spectrum of technologies and processes. Thus, Society and organizations are manage by planning. From the massive amount of unstructured and heterogeneous data collected about people, actions, sensors and the web arises the challenge to efficiently manage, analyze and visualize it. A consequence of this are dramatic impacts of societal and organizational decision making. According to [13], the Cloud Computing paradigm provides fundamental support to address the challenges with shared computing resources including computing, storage, networking and analytical software; the application of these resources has fostered impressive Big

Data advancement. Over the years some approaches for a IoT Cloud based platform were made. With focus in providing a service able to extract aggregated value from IoT based solutions Amazon created a set of cloud based products. Among them, AWS IoT Core is a platform that provides interfaces to aid final users manage its IoT devices. The main objective is to allow secure connection of IoT devices and Cloud Computing applications. Amazon FreeRTOS is an operating system for microcontrollers. AWS FreeRTOS aim to facilitate the programing, deployment, connecting and management of small low-end edge devices. AWS IoT 1-Click is a service made over lambda architecture that enable low-end devices to perform simple tasks. Empowered with publisher-subscribe protocols Google Cloud IoT is a set of integrated services that encompass secure exchange and storage of IoT data into the Google Cloud environment with the objective to use Google Big Query to perform data analytics. Dweet is an online news and social networking service for IoT on which devices post chunks of information in a publisher-subscribe manner. The platform provides a simple web api that enable the user to visualize its things posted information as short messages.

3 The Heimdall Platform

The emergence of IoT Ecosystem is envisioned to transform the environment and the way society organizes itself [6]. From the emergence of interconnected small environment with sensor-enabled connected devices and built in learning capabilities enables the recognition on how people interact with surrounding environment and how everyday activities are perform are inexorable. Nevertheless, to make feasible such scenario key challenges are yet to be overcome. One of then concern how everyday objects became components of a more complex and more powerful network of systems, a network of smart environment (smart objects as part of an Ecosystem) in order to contribute to increase quality of life.

Heimdall is envision as a Ecosystem that reunites favorable conditions for the SIoT paradigm flourish. Inspired by biological systems, Figure 1 shows how abet the development of a community made up of organisms interacting and collaborating in a common environment. In biology, an ecosystem is a unit flooded by different organisms that share the same habitat resources [15]. With the objective of making these integration feasible, Heimdall proposes that the ecosystem environment must be a series of microservices which constitute a series of components that promote flexible and scalable cloud solutions. Such organisms interact and collaborate with each other according to their interest to reach individual or collective objectives. Analogously, Heimdall represent the things (the IoT smart objects) as resources which are Heimdall organisms. The things can be a standalone sensor, a WSN, and IoT system for a smart home and so on. To enhance the IoT services, the interaction and collaboration have an important role, because better results (services in IoT context) are obtained in network than by an individual or a small group [14]. Then, Heimdall adopts the SIoT paradigm as the model for interactions among smart objects, because social networks pro-

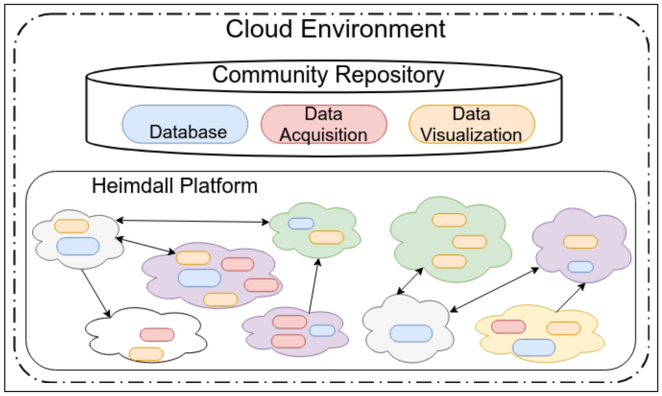

Fig. 1. Heimdall Platform

vides dynamic, robust and flexible models of interactions that can provides a new level of network for objects. Contrary to social network that motivated web applications (called social media) to support human interactions, in the IoT context the objects where connected first in the Internet, some service where made and then the SIoT proposes is adopt humans interactions models to enhance the interactions, collaboration and services provided by IoT.

The Heimdall platform is the habitat that will favor the creation of these ecosystems and benefits that services as data collector, database, data visualization, data fusion and others, can be provided, shared and improved progressively. Heimdall microservices are images that can be instantiated to compose a resource in Heimdall. Therefore, a repository service to registry and search microservice should be available. Then, the resources can interact with any other resource though the adoption of specialized communication microservices. As an example of microservice benefits, as the SIoT solutions are being made available, they can also be improved, adapted and shared as microservices. We should point out that this example also motivated the enhance of SIoT, since give human interaction skill to objects are a complex task that requires hard work.

4 Final Considerations

This paper depict some motivations and challenges related to IoT ecosystem and how IoT services could be enhanced when they share a common environment that provide them which interact and collaborating. A microservice platform to support IoT ecosystem (named Heimdall) was also presented and its key aspect was described. Heimdall is a reference microservices platform to support IoT ecosystems in a scalable, reusable and flexible way. At the same time, a platform as Heimdall allows users focus manly on the IoT solutions on the level of devices, since they will just need instantiate microservice Heimdall's images. We aim contributing to fuel the development of complex Smart Concepts (smart ecosystems), in turn, the unfolding the full potential of the SIoT paradigm. As future works we intend to explore the depicted challenges.

As threats to the validity of Heimdall the scarcity of SIoT concrete and good enough solutions and the need of the creation of diverse microservice images useful are important to highlight. As future work we hope to improve the Heimdall repository and turns it available. To do this, we have to define some constraints about basic features and interfaces for all new image before they are inserted in the repository. Besides, nowadays the instantiation of images are made through service that requires an expertise. So, an easy to use interface will be created to any user to be able to instantiate microservice images.

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